

ABSTRACT

Improved methods for manufacturing semiconductor devices incorporating barrier layers at metal/dielectric interfaces include the use of nitrogen-rich plasma, ion beam implantation and/or electromagnetic radiation to form regions of nitrided metal. The barrier layers decrease the diffusion of dopants such as fluorine, phosphorous and boron from the dielectric material into the metal, thereby decreasing the formation of metal salts. By decreasing the formation of metal salts, the barrier layers of this invention decrease the formation of voids and areas of delamination, and thereby decrease the loss of electrical reliability during manufacture and during use. Additional aspects of this invention include methods for monitoring the deposition of thin metal films using sheet resistance measurements, and further embodiments of this invention include methods for monitoring the surface texture of films that undergo phase transitions. Additional embodiments include methods for monitoring and calibrating the temperatures of manufacturing processes on the surfaces of semiconductor wafers. Thus, useful lifetimes of semiconductor devices can be increased, and the manufacture of reliable devices can be easier, less expensive and more reproducible.